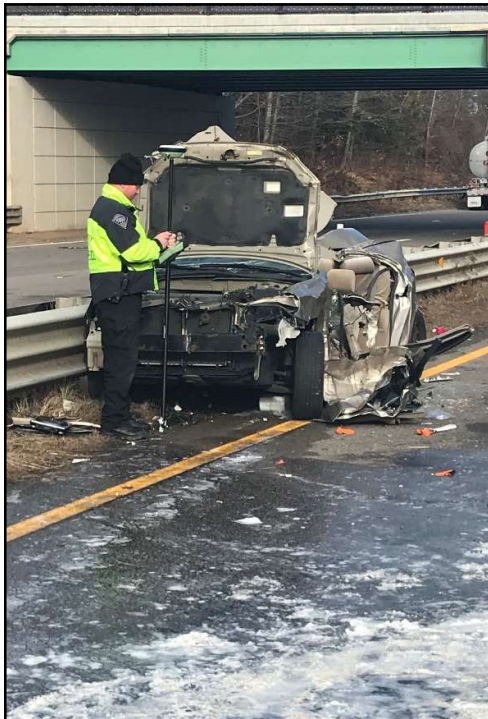


Improving Data Accuracy from the Scene of Motor Vehicle Crashes

Presented by Detective Lieutenant Rick Wolanski #3203
Massachusetts State Police
Collision Analysis & Reconstruction Section

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DLt Rick Wolanski

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- Member of the Massachusetts State Police for 18 years
- Assigned to CARS since 2012
- Current position is Section Commander of CARS
- Investigated 300+ fatal/serious injury crashes

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Project Goals

- Train and certify current members of CARS in crash investigation involving pedestrian and bicyclists
- Train and certify current members of CARS in recognizing, analyzing, and measuring the human response in dynamic crash situations
- Provide up-to-date, calibrated equipment to all members of CARS to precisely measure roadway value
- Provide training/familiarization for all CARS members for new equipment
- Creation of an indexed database incorporating roadway measurements

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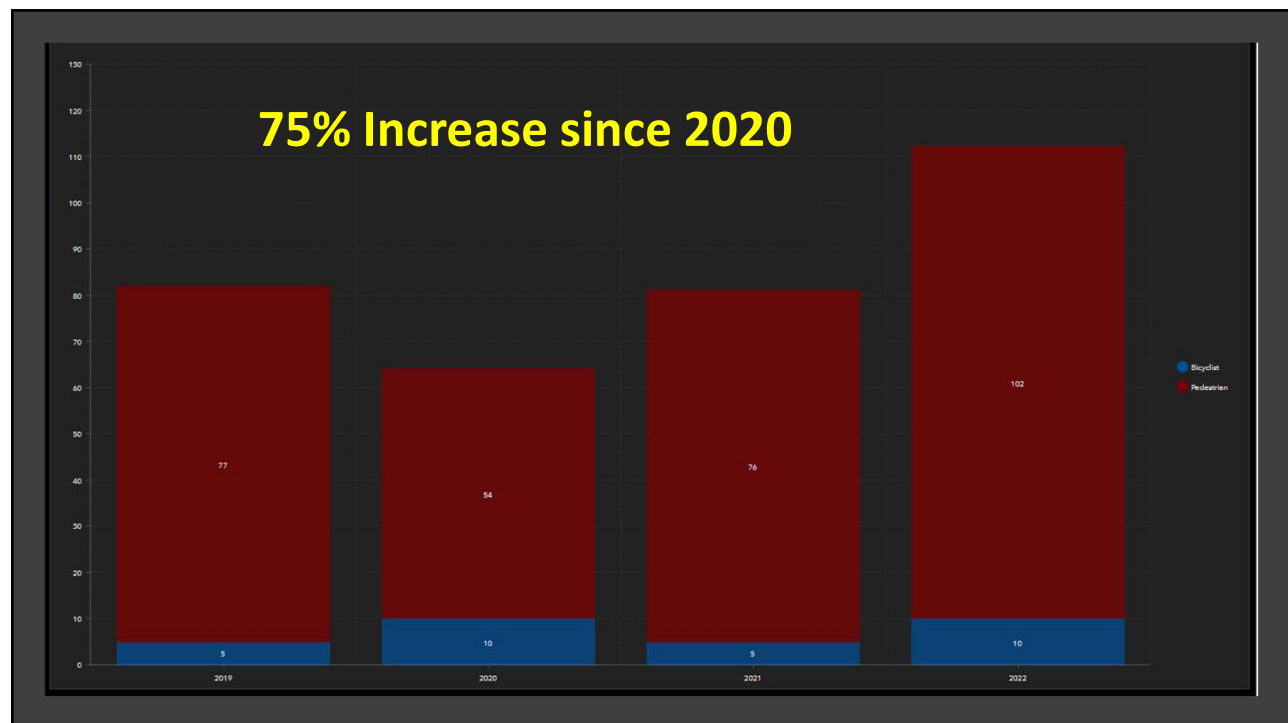
Proposal

- Host a forty (40) hour course in Pedestrian & Bicycle Crash Investigation
 - Total cost \$15,000
- Host a forty (40) hour course in Advanced Human Factors
 - Total cost \$22,000
- Purchase twenty-four (24) GPS-based portable accelerometers with cases
 - Total cost \$18,788.64
- Purchase twenty-six (26) calibrated drag sleds and hand scales
 - Total cost \$25,551.50
- Total project cost: **\$81,340.14**

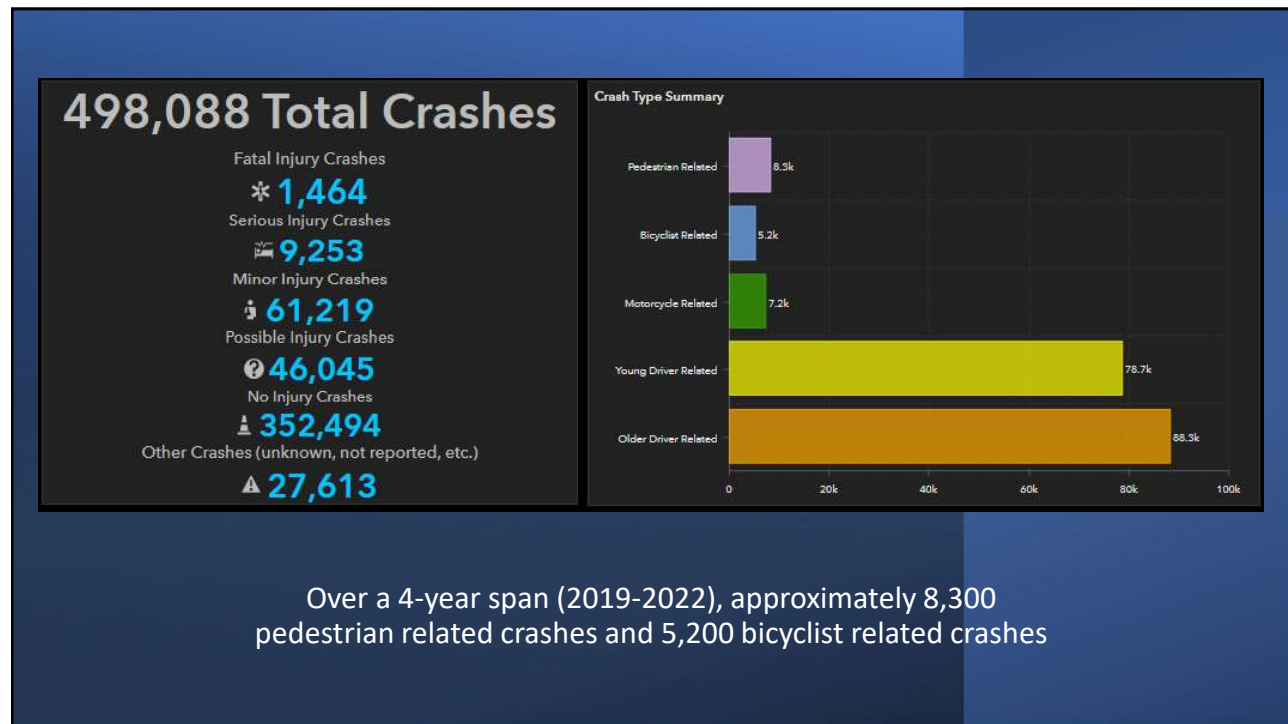
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Automobile crashes involving pedestrians and bicyclists are on the rise

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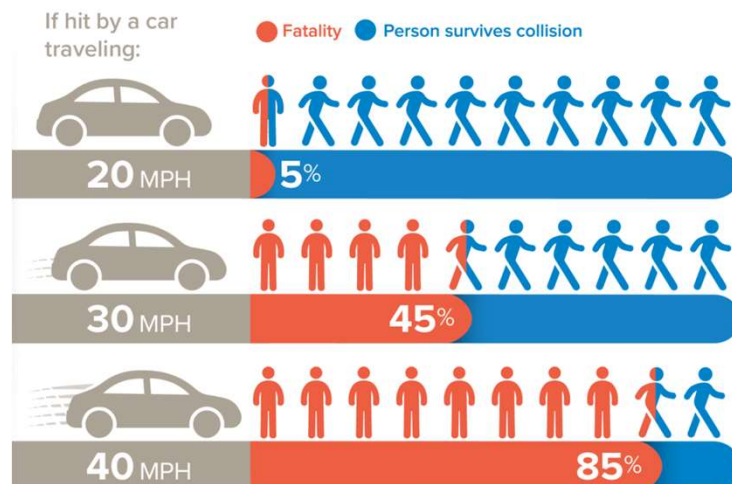
Special Problems in Crash Investigations

- Increasingly, reconstruction resources are going to investigating pedestrian crashes
- These investigations are complicated and lengthy, often involving several elements of analysis
- Crash dynamics in pedestrian crashes are very different than crashes involving two objects of comparable mass and velocity

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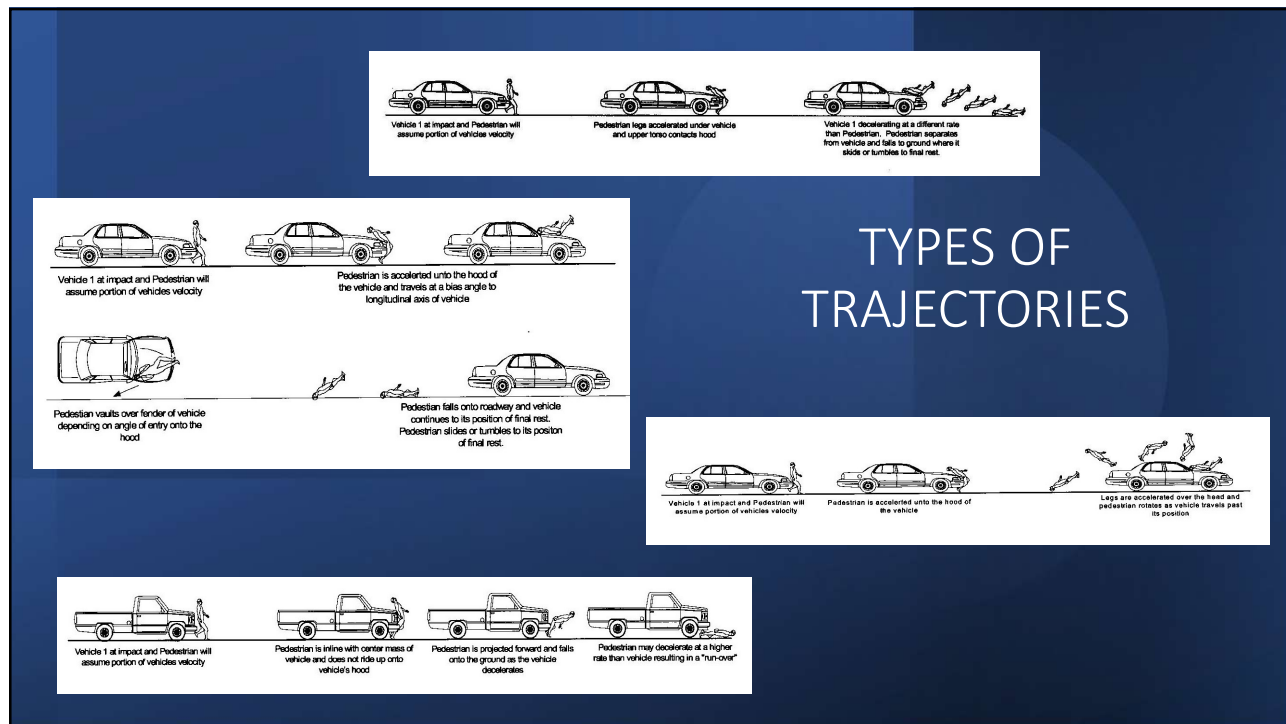
Pedestrian Crashes

- A growing problem, particularly in urban areas
- Lower speed crashes can still result in serious or fatal injuries

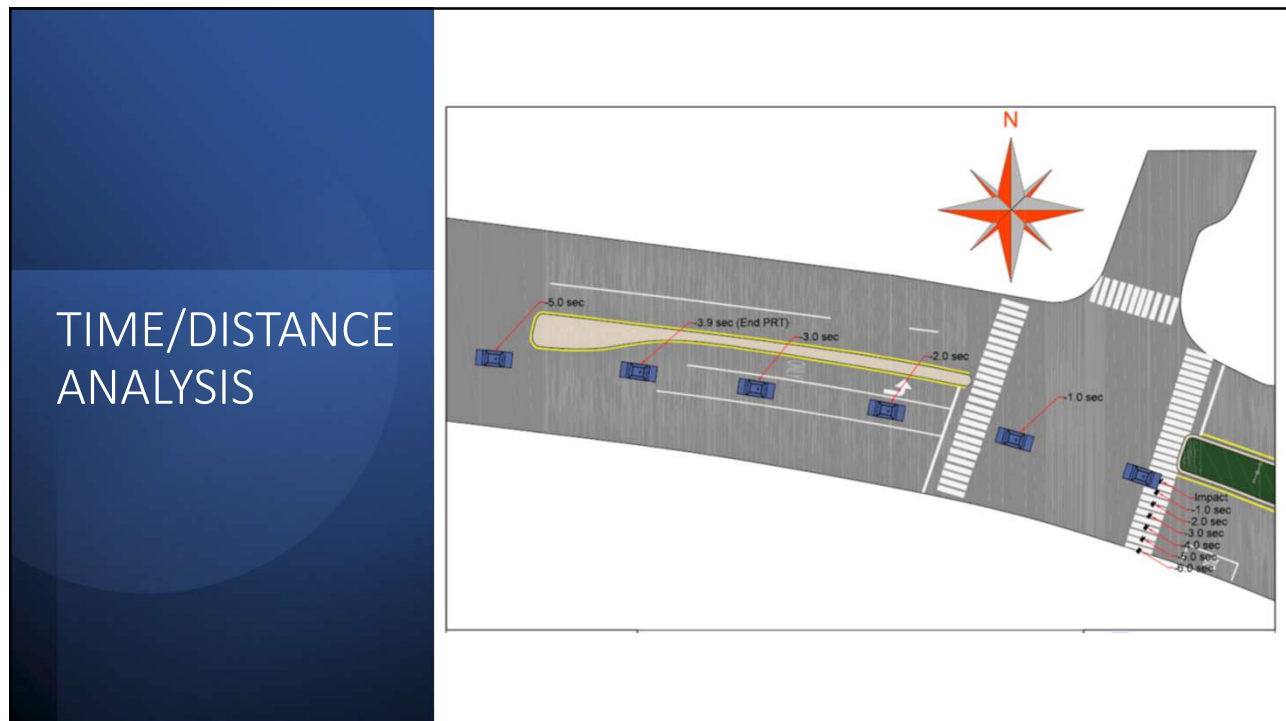


National Traffic Safety Board (2017) Reducing Speeding-Related Crashes Involving Passenger Vehicles.
Available from: <https://www.nts.gov/safety/safety-studies/Documents/SS1701.pdf>

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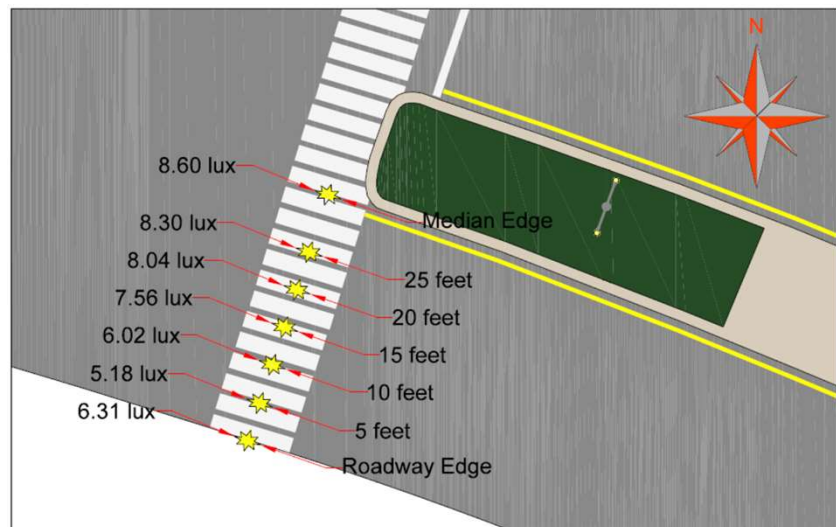


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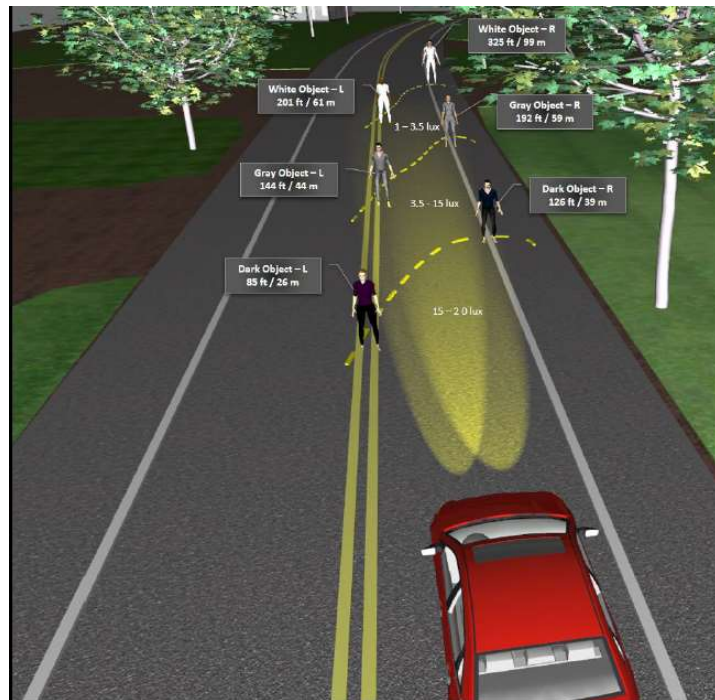
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LIGHTING



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VISIBILITY



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Tying in the Human Factor

- Critical to any crash, and particularly in pedestrian crashes, in incorporating the way humans behave when confronted with a critical, split-second decision
- This becomes a life-or-death decision when a driver encounters a pedestrian as a hazard
- Extensive research has been done over many years to examine and quantify human reactions
- The Human Factors class incorporates these research elements to apply to specific crashes under investigation

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THE HUMAN FACTOR

- Gap Acceptance
 - When will average drivers engage when there is a gap in traffic?
- Headlight Analysis
 - What will the headlights illuminate?
- Pedestrian walking/running speeds
- Sun Position
- Night Recognition
- Perception-Reaction Time

PATH INTRUSION

5. Hazard & Appro Response Unknown ***DEFAULT***

4. Road/HI Fidelity Sim ***DEFAULT***

1. Driving

10 deg (~road side)

1. Subj did not discern other unit stop

0. SV Not Turning

Brake Lag 375 ms

messachusetts state police © CSS, LLC

2018-CAR-000274

Check if using Mobile

2. Night

1. Response to one object

2. More info (i.e. intersection, curve, fla

Check if hovering brake

Braking Adj + (413 x Tr) + 30E + 224Lt + 716O - 496Tp - 164M + 261Tn + 350(D - 1) + 7 eq.1

125 + (413 x 3) + 30x10 + 224x2 + 716x1 - 496x2 - 164x1 + 261x0 + 350 x (1 - 1) + 7 eq.2

85th percentile response

AVERAGE PRT	1.6 sec	2.2 sec	Individuals
Equation	1.7 sec		
All Path Intrusions	1.6 Sec	1.2 Sec	2.0 Sec
Resp to Vehicle	1.6 Sec	1.3 Sec	1.9 Sec
Resp to Pedestria	1.5 Sec	1.2 Sec	2.0 Sec
Resp to Object	1.5 Sec	1.2 Sec	1.8 Sec

Min Avg Max Avg Scenarios

Li & Ferni (2010) NC & Weather +28.3% (1.39 & 1.28 / 1.72 & 1.7)

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Why These Classes?

- Understanding the dynamics at play is essential to correctly investigate these crashes and, ultimately, determine cause
- As pedestrian crashes become more frequent, more of CARS resources are dedicated to these investigations
- Without understanding HOW these crashes happen, we will be unable to enact policies to PREVENT deaths in the future

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Why These Classes?

AS OF TODAY:

- 9 CARS Troopers (out of 26) have received the Pedestrian/Bicycle class (only 6 within the last 5 years)
- 9 CARS Troopers (out of 26) have received the Human Factors class (last held in 2018)
- Both fields of study are growing rapidly, and contemporary approaches & techniques would be invaluable for those of us that have already sat for the training

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CLASS DESCRIPTIONS

Pedestrian/Bicycle Crash Investigation – Level 1

- Offered by the Institute of Police Technology & Management (IPTM)
- 40 hours course with a certification upon completion
- Addresses the special dynamics involved in pedestrian and bicycle traffic crashes
- Topics Include:
 - Pedestrian crash problems
 - Pedestrian impact dynamics
 - Types of data: objective, subjective and performance
 - Collection of data
 - Pedestrian conspicuity
 - Reaction time/human factors
 - Reconstruction techniques
 - Bicycle collision analysis
 - Hit and run investigation techniques

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CLASS DESCRIPTIONS

Advanced Human Factors

- Offered by the Institute of the Driver Research Institute
- 40 hours course with a certification upon completion
- Addresses human perception and response factors in crash investigation
- Topics Include:
 - Methodology and application of Interactive Driver Response Research (I.DRR) software
 - Perception/response factors
 - Sun position (solar glare)
 - Night recognition
 - Weather
 - Path intrusion
 - Gap Acceptance
 - Lead Vehicle
 - Avoidance
 - Current research and methodology regarding pedestrian walking speeds, headlight analysis, and vehicle spray

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FRICITION – why does this matter?

Friction is used in most of the speed calculations in reconstruction.

It can also fluctuate depending on the instrument and when it was taken.

It is a common area to challenge in an analysis. A misuse of friction can be used to cast doubt on the expertise of the witness.

$$V_{min} = \sqrt{\frac{2 \times g \times f \times D}{1 + f^2}}$$

$$V_{max} = \sqrt{2 \times g \times f \times D}$$

$$S = \sqrt{30 \times D \times f}$$



$$f = (fr + ((\mu - fr) \times |S \sin \alpha|))$$

$$V = \frac{\sqrt{2 \times g \times f \times D}}{\cos \theta + (f \times \sin \theta)}$$

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FRICTION

Friction is the resisting force to motion between 2 surfaces at their point of contact.

As used in crash reconstruction, friction is represented as a ratio between the force on an object (a tire) and the weight of the object:

$$\mu = \frac{F}{w}$$

The terms drag factor, frictional value, and coefficient of friction are generally interchangeable, and often represented by the Greek letter μ .

Friction is a ratio and has no terms. It is represented as a decimal to 2 places.

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3 WAYS TO OBTAIN FRICTION VALUES

- Measure on scene with an accelerometer
- Measure on scene with a drag sled
- Obtain value from a table (usually derived from research and testing)

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ACCELEROMETER

- The best (most reliable) way to measure friction is with an accelerometer
 - An accelerometer is a sophisticated device that measures the change in velocity in a moving object
 - The accelerometer can then calculate:
 - Acceleration rates
 - Braking efficiency
 - Frictional value of the roadway
- The Vbox Sport uses GNSS geolocation coordinates to measure change in distances over time
- They can be mounted on vehicles, motorcycles, even bicycles
- They transmit data to a smart phone app
- They are a common and accepted measuring device in the field of Reconstruction
- Purchased from Racelogic, Farmington Hills, MI



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DRAG SLED



- When the accelerometer is not available (or not practical) a drag sled is used
- The "sled" is dragged across the roadway with a scale; the scale tells us the pounds of force, and that is divided by the weight of the sled
- Friction is not particularly sensitive to changes in tire composition, as much as roadway surfaces/conditions, which makes drag sleds a reliable alternative
- At present, just over half of CARS Troopers have drag sleds which are all DIY and uncalibrated
- The purchase of factory-made sleds and scales will have the advantage of being
 - Properly calibrated
 - A consistent weight and composition
 - Industry-accepted alternative to the accelerometer
- Purchased from MEDTECH Forensics, Tallahassee, FL

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DRAG SLEDS

TOTAL COST

- | | |
|---|--------------------|
| • Twenty-six (26) Braker Box drag sleds | \$13,214.50 |
| • Twenty-six (26) Chatillon IronClad scales | \$12,337.00 |
| • Total Cost | \$25,551.50 |

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ROAD SURFACE	DRY		< 30 mph		DRY		> 30 mph		WET		< 30 mph		WET		> 30 mph	
	From	To	From	To	From	To	From	To	From	To	From	To	From	To	From	To
PORTLAND CEMENT																
New, Sharp	0.80	1.20	0.70	1.00	0.50	0.80	0.40	0.75								
Traveled	0.60	0.80	0.60	0.75	0.45	0.70	0.45	0.65								
Traffic Polished	0.55	0.75	0.50	0.65	0.45	0.65	0.45	0.60								
ASPHALT/TAR																
New, Sharp	0.80	1.20	0.65	1.00	0.50	0.80	0.45	0.75								
Traveled	0.60	0.80	0.55	0.70	0.45	0.70	0.40	0.65								
Traffic Polished	0.55	0.75	0.45	0.65	0.45	0.65	0.40	0.60								
Excess Tar	0.50	0.60	0.35	0.60	0.30	0.60	0.25	0.55								
GRAVEL																
Packed, Oiled	0.55	0.85	0.50	0.80	0.40	0.80	0.40	0.60								
Loose	0.40	0.70	0.40	0.70	0.45	0.75	0.45	0.75								
CINDERS																
Packed	0.50	0.70	0.50	0.70	0.65	0.75	0.65									
ROCK																
Crushed	0.55	0.75	0.55	0.75	0.55	0.75	0.55									
ICE																
Smooth	0.10	0.25	0.07	0.20	0.05	0.10										
SNOW																
Packed	0.30	0.55	0.35	0.55	0.30											

DATA TABLES

- Least reliable source
- Usually give a range
- Can be difficult to determine origin and/or accuracy
- Roadway composition can vary significantly from region to region

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LOCALLY SOURCED DATA TABLES

- By using this new equipment, CARS Troopers can begin recording and compiling measurement data
- A number of factors can affect frictional values, such as
 - Time of day
 - Time of year
 - Weather
 - Road surface
 - Temperature
- Last year, CARS responded to and investigated 458 crashes
- Combined with data points already collected in every crash investigated, we can very quickly build a significant source of reliable data that can be catered to specific crash conditions

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CARS DATA TABLES

- Frictional data collected from investigations will be collected at the conclusion of each investigation.
- A data table will be created, to include
 - Measured frictional value
 - Method used to acquire the measurement
 - Roadway characteristics
- The expectation is that when the MSP begin a new reporting system (migrating from RAMS to ACISS) the new system will support a data field specifically for these measurements

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QUESTIONS?

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